AOS 580: Aerosol, cloud and climate

Lecture 1. Logistics and Introduction

LOGISTICS

24 lectures; 5 problem sets; 1 midterm exam; 1 final exam.

Meeting Time: Tuesday and Thursday: 9:00-9:50 AM

Place: Guyot Hall, Room 220

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References:

IPCC 2007: P. Forster and V. Ramaswamy, Chapter 2. Changes in Atmospheric Constituents and in Radiative Forcing, in Climate Change 2007: The physical Science basis, Intergovernmental panel on climate change, Cambridge University Press, Cambridge, 2007.

Aerosol properties: J. H. Seinfeld and S. N. Pandis, Atmospheric Chemistry and Physics: from air pollution to climate change, Wiley & Sons, New York, 1998.

Aerosol modeling: G. P. Brasseur, J. J. Orlando, and G. S. Tyndall, Atmospheric chemistry and global change, Oxford University Press, New York, 1999.

Aerosol measurements: J. N. Pitts and B. J. Finlayson-Pitts, Atmospheric chemistry: Fundamentals and experimental techniques, Wiley & Sons, New York, 1986.

INTRODUCTION

1. What are atmospheric aerosols?

Aerosols designate a suspension of particles, either solid or liquid, in a gaseous environment. Example: aerosol from spray canister

Atmospheric aerosols (or particulate matter) are solid or liquid particles or both suspended in air for at least several hours, excluding cloud droplets and ice crystals.

- Aerosol particles vary greatly in size, source, chemical composition, amount and distribution in space and time, and how long they survive in the atmosphere.

Primary atmospheric aerosols are particulates that emitted directly into the atmosphere (for instance, sea-salt, mineral aerosols (or dust), volcanic dust, smoke and soot, some organics).

Secondary atmospheric aerosols are particulates that formed in the atmosphere by gas-to-particles conversion processes (for instance, sulfates, nitrates, some organics).

Importance of atmospheric

Aerosol effect on Air Quality

- Air quality:
  - Respiratory distress, eyes irritation
  - Reduction of visibility
  - Acid rain

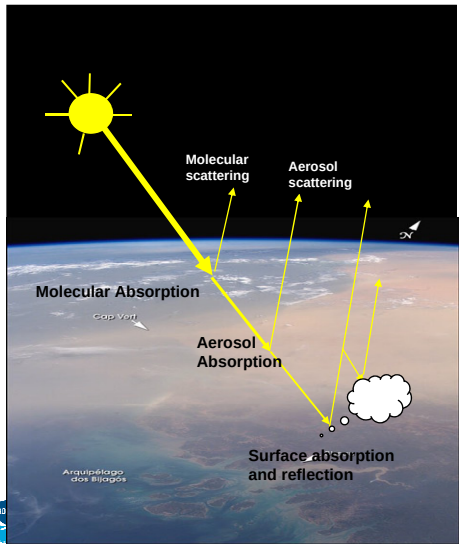
Doing some shopping in Beijing by a nice dusty day

Convoy of trucks in a dust storm Taklamakan, China

A birch and pine forest, killed by acid rain from a nearby nickel smelter,Monchegorsk, Russia

aerosol:

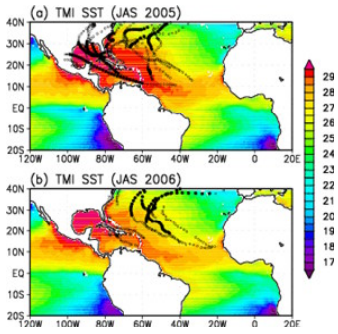
Aerosol effect on Climate



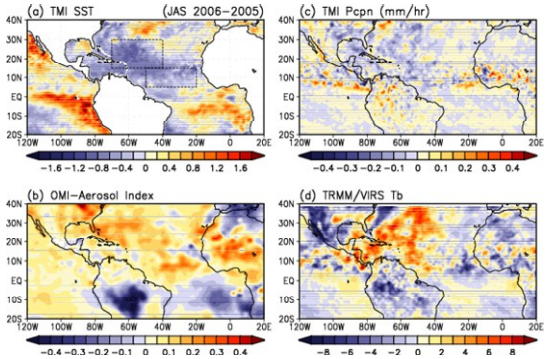
- Climate:
  - Direct: scattering and absorption of solar and infrared radiation
  - Semi-direct: clouds burn-off by absorbing aerosols
  - Indirect: modify clouds properties
    - 1st : brighter clouds
    - 2nd : decrease precipitation efficiency

Aerosol effect on hurricane genesis

SST and tracks of ropical storm and hurricane in 2005 and 2006



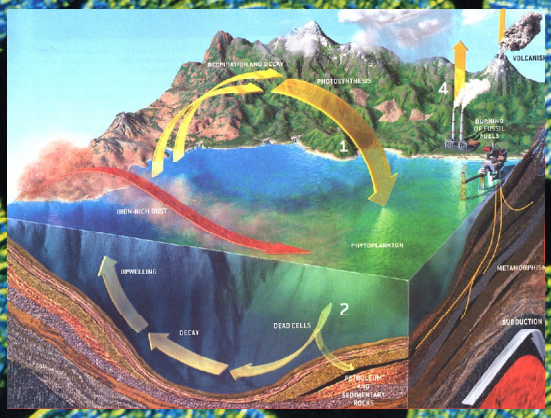
Difference between J-A-S 2006-2005 of SST, OMI-AI, TRMM precipitation and cloud top temperature



Lau, K.-M., and K.-M. Kim, How nature foiled the hurricane forecasts, Eos. Trans. AGU, 88, No.9, 2007

Dust aerosol increase atmospheric stability and wind shear which may alter hurricane genesis.

Aerosol Effect on Biogeochemistry

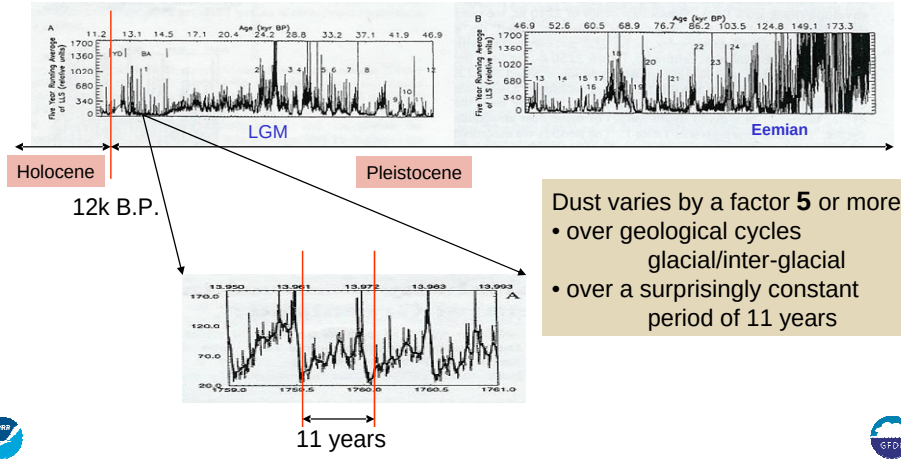


Paul G. Falkowski, Scientific American, August 2002

Aerosol as tracer of climate change

Observed Variability of Dust for the last 100k years

Laser Light Scattering by dust in Greenland ice core (Ram et al., 1997)



Dust varies by a factor **5** or more
- over geological cycles
  glacial/inter-glacial
- over a surprisingly constant
  period of 11 years

Aerosol feedback on climate

Example of positive feedback by dust aerosol

Increase atmospheric dust burden will increase, in D-J-F, the Azores anticylcone which in turns increase dust emission.